



## Poles and zeroes with positive normalization factors

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Poles and Zeroes for all Guralp instruments are obtained by the frequency response of the instrument. They are measured using the HP spectrum analyzer and a curve is then fitted to this data. All poles and zeroes supplied with Guralp equipment are derived from actual measured data and not generated from examination of theoretical calculations.

The system that Guralp Systems uses produces the lowest order transfer function that fits the data. For the response of the instruments this function always has a negative normalization factor.

Whilst negative normalization factors are mathematically correct and give the correct results, Guralp Systems has been made aware that the SEED convention does not allow for them and that the standard RDSEED conversion program does not handle negative normalization factors properly.

By increasing the order of the transfer function, we have been able to provide an alternative fit to the data with a positive normalization factor.

All instruments that have their frequency responses measured at GSL have their frequency response data held on file here.

Because the instruments are true feedback instruments, their response is entirely defined by the parameters in the feedback path. The frequency response of instruments is within 0.1 % at the long period end and within 2 % at the high frequency end.

## Values

### 360 Second CMG-3T & CMG-1T Poles and Zeroes (in Hz)

Zeroes	Poles	Normalization Factor at 1 Hz
0	-80.0	A = 2 304 000
0	-160.0	

-180.0  
 -0.001964 + 0.001964j  
 -0.001964 - 0.001964j

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### 120 Second CMG-3T, CMG-3ESP & CMG-1T Poles and Zeroes (in Hz)

Zeroes	Poles	Normalization Factor at 1Hz
0	-80.0	A = 2 304 000
0	-160.0	
	-180.0	
	-0.00589 + 0.00589j	
	-0.00589 - 0.00589j	

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### 100 Second CMG-3T, CMG-3ESP & CMG-1T Poles and Zeroes (in Hz)

Zeroes	Poles	Normalization Factor at 1Hz
0	-80.0	A = 2 304 000
0	-160.0	
	-180.0	
	-0.00707 + 0.00707j	
	-0.00707 - 0.00707j	

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### 60 Second CMG-3T, CMG-3ESP, & CMG-40T Poles and Zeroes (in Hz)

Zeroes	Poles	Normalization Factor at 1Hz
0	-80.0	A = 2 304 000
0	-160.0	
	-180.0	
	-0.01178 + 0.01178j	
	-0.01178 - 0.01178j	

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### 30 Second CMG-3T, CMG-3ESP & CMG-40T Poles and Zeroes (in Hz)

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<b>Zeroes</b>	<b>Poles</b>	<b>Normalization Factor at 1Hz</b>
0	-80.0	A = 2 304 000
0	-160.0	
	-180.0	
	$-0.02356 + 0.02356j$	
	$-0.02356 - 0.02356j$	

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### 1 Second to 100 Hz , CMG-40T Poles and Zeroes (in Hz)

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<b>Zeroes</b>	<b>Poles</b>	<b>Normalization Factor at 5Hz</b>
0	-75.0	A = 585 800 000
0	-350.0	
	$-0.707 + 0.707j$	
	$-0.707 - 0.707j$	
	$-62.3816 + 135.392j$	
	$-62.3816 - 135.392j$	

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### DC to 100 Hz , CMG-5T / CMG-5TD / CMG-5TB Poles and Zeroes (in Hz)

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<b>Zeroes</b>	<b>Poles</b>	<b>Normalization Factor at 1Hz</b>
	-755.89	A = 1 939 000 000
	-209.65	
	$-63.79 - 90.38j$	
	$-63.79 + 90.38j$	

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